Central Manchester University Hospitals NHS
NHS Foundation Trust

Directorate of Laboratory Medicine – Clinical Biochemistry

Adult User Guide

Clinical Biochemistry

Controlled Document

CLINICAL BIOCHEMISTRY

This guide describes the Clinical Biochemistry service provided for adult patients (patients over 18 years old). Please see the separate Paediatric Biochemistry Guide for children and neonates.

Location

The Clinical Biochemistry Department provides a comprehensive service for the care of patients within the Trust and the wider community served by both the Primary and Tertiary sectors.

The high volume testing, including the urgent and 24 hour access assays, are carried out in the Autolab on the ground floor of the Clinical Sciences Building (CSB3). This also houses the main specimen reception and most of Haematology, including Blood Transfusion.

Specialist assays are carried out in laboratories on the 1st and 2nd floor of CSB3. The Point of Care team are housed on the 4th floor of the new Children's Hospital.

Opening Hours

The core opening hours of the laboratory are 8.00am to 5.00pm Monday-Friday. Outside of these hours a reduced service is available as part of the CPP service (Continuous Process Pathology). We aim to provide an extensive range of routine assays e.g. Renal, Bone, Liver, Lipid and Cardiac profiles at all times. A full emergency service is always available and this is listed separately below. The out of hours service is manned by a limited number of staff from 5.00pm to 8.30am and only one Biomedical Scientist **is** available between 8.30pm and 8.30am. **Please keep use of the service to a minimum between these times to enable us to provide the most efficient urgent and emergency service in these periods.**

General information

The department is manned by various clinical and technical staff, below is a list of all key person**nel**

Katharine Hayden	Consultant Clinical Biochemist Specialist interest in Endocrinology & Automated Services (Head of Service)	Tel 0161 70 11106
Dr C Chaloner	Consultant Clinical Biochemist Specialist interest in Paed**i**atric Biochemistry (Deputy Head of Service)	Tel 0161 70 12752
Dr G Ayers	Consultant Clinical Biochemist Specialist interest in Toxicology	Tel 0161 27 64594
Dr M France	Consultant Chemical Pathologist Specialist interest in Metabolic Biochemistry	Tel 0161 27 64284
Ms Christine Hill	Laboratory Manager	Tel 0161 70 11201
Dr Adrian C Holt	Senior Clinical Biochemist, Clinical Trials	Tel 0161 27 64579
Dr Allen P Yates	Principal Clinical Biochemist Clinical Research	Tel 0161 70 11213
Dr D Schofield	Clinical Biochemist, Pancreatic Laboratory	Tel 0161 27 64067
Dr Jacquie Berry	Research Fellow, Vitamin D service	Tel 0161 27 6830
Mr Chris Reeves	Principal Clinical Biochemist	Tel 0161 70 11206

Controlled Document

Mrs Allison Gaskell	Chief BMS – Auto lab	Tel 0161 27 65574
Mr Neil Howarth	Chief BMS – Specialist section	Tel 0161 27 64699
Ms Carol Chadwick	POCT Co-ordinator (SMH & RMCH)	Tel 0161 701 2216
Ms Emma James	POCT Co-ordinator (MRI, REH and external locations)	Tel 0161 27 64891
Departmental Fax		Tel 0161 27 64586

Results and Clinical Advice

Results Line

If you need to telephone for results call the 'Results-Line' **0161 276 8766 Monday–Friday 8.00 am–8.00 pm**

Duty Biochemist

Clinical advice is available at all times. The duty biochemist is one of the Clinical Scientists or medical staff and includes those on the list above. They participate in a rota and will assist and advise on problems involving the biochemical investigation of patients and the interpretation of results.

The Duty Biochemist can be "bleeped" on 4375 during normal hours. Out of normal hours, one of the Consultant staff is available via the Trust switchboard.

Out Of Hours specialist contact

Outside of normal working hours contact is made directly by mobile phone or "Air-Bleep" via switchboard.

Mobile number: 07771 703383

Controlled Document

SERVICES AVAILABLE

Service provision

Specimen reception is open for the receipt of samples at all times. Printed reports are distributed to all wards and departments twice daily Monday-Friday at approximately 10.00am and 4.00pm. If you wish to have results of specimens for routine biochemical profiles included on these reports on the same day, the samples **must** arrive in the laboratory no later than 1.00pm.

Emergency requests and blood gases

The list below shows those analytes that are provided on an Urgent and Emergency basis. Samples requiring these tests and labelled as Urgent will usually be analysed and reported in 60-120 minutes from receipt in the laboratory. If results are required very rapidly for the immediate treatment of a patient, or if you wish to send a sample for arterial blood gases and pH, please contact the laboratory to let us know that the sample is coming. Contact details are:-

Monday - Friday	8.00am-5.00 pm	Tel. 0161 27 64375
Saturday - Sunday	8.00 am -12.00 noon	Tel. 0161 27 64375
All other times		Tel. 0161 27 64375 **or** bleep 2722

Access to urgent and emergency requests

Analytes other than those on the list below may be analysed on an urgent or emergency basis but **only** after consultation and arrangement with the Biochemistry Department.

Requesting urgent analyses

The following analytes are available at any time:

Albumin
Amylase
Bicarbonate
Bilirubin
Blood gases
Calcium
Carboxyhaemoglobin
Chloride
Creatinine
Creatine Kinase
Digoxin
Ethanol
Glucose
Iron
Lithium
Liver Profile
Magnesium
Methaemoglobin ***(in heparinised bottle if not sent with blood gas)***
Osmolality
Paracetamol
Potassium
Renal Profile
Salicylate
Sodium
Theophylline
Troponin T
Urea
Urine Paraquat ***(phone 64375 to advise of sample being sent)***
Quantitative BHCG (blood pregnancy only)

IMPORTANT

1. You must arrange transport of the sample using the portering service, pneumatic tube system or ward staff.
2. Results of these tests are available in between one hour and two hours of receipt of the sample in the laboratory.
3. The pneumatic tube must **not** be used for transport of blood gas samples.

Controlled Document

REQUESTS FOR INVESTIGATIONS

Hospital in-patients and out-patients

All requests should be made using the hospital computer system. This is the Clinical Work Station **(CWS)** of the **Patient Administration System (PAS).** For those areas not covered by CWS, the pre-printed biochemistry request form should be used, with patient labels if possible.

Primary care requests

We provide multi-discipline request cards for all practices which we have an agreement to provide services for. See the section on GP services in section 3 of this document for contact information

All samples and request cards should have as much information on as possible to enable us to positively identify the patient that the sample has come from, to ensure that the sample and card relate to the same person and to identify which tests need doing and any other requirements. For some assays it is essential that we know the time that the sample was taken. This is especially important in the case of therapeutic drug monitoring. It is preferred that samples are labelled with pre-printed labels from the patient's notes. If handwritten the tube should as a minimum be labelled with surname, first name and hospital record number or other unique identifier such as NHS number

SPECIMEN ACCEPTANCE

A copy of the Directorate Specimen Acceptance policy is included in the DLM user guide. In summary;

Samples must be labelled with 3 unique identifiers from;

1. Unique identification number (e.g. hospital number, case note number, NHS number)
2. Surname
3. Forename
4. Date of birth

The request form data MUST match the above information on the specimen.
Foe therapeutic drug monitoring requests the form and / or sample should have the following information added ;

1. Name of drug
2. Dose of drug
3. Time of last dose
4. Time of specimen in relation to the time of the last dose.

Multiple specimens (e.g. Dynamic function tests) MUST include the time of each sample on specimen and request cards using the 24 hour clock format.

The request form should also include the following information;

- The patients location / destination for the report.
- The tests required
- Name of consultant or GP
- Name of requestor and a contact number (telephone or bleep no.)
- Date and time that specimen was collected.
- All clinical information required for proper interpretation of the test result.
- Patient address for GP requests.

The sender of the sample will be notified as soon as possible if the sample is inadequately labelled so that the investigation can be repeated if it is still required.

Inadequately labelled or unlabelled samples will NOT be analysed.

The request form should be sent to the laboratory, with the appropriate specimen sealed in a plastic bag, by the specimen transport system (pneumatic tube) or by messenger porter or ward staff. The forms must be kept separate from the samples. Specimens and forms for individual Laboratory Medicine Departments must

Controlled Document

be sent in individual specimen bags to avoid delays in processing. An electronic request via CWS is preferred.

If tests are requested using the CWS system an electronic report will be sent back to the unit from which the request was made.

Controlled Document

SPECIMEN REQUIREMENTS AND REFERENCE RANGES

Specimen requirements and reference ranges are shown in the following tables (analytes arranged alphabetically).

Please note:

- Ranges are for adults.
- Desirable values rather than population reference ranges are given for lipids and HbA1c.
- Information from, or copies of, the various guidelines referred to (e.g. European Arthrosclerosis Society Guidelines) can be obtained by contacting the Duty Biochemist.
- To simplify requesting, a number of **organ specific** blood profiles are available. The tests included in these are listed below:

Renal profile	sodium, potassium, urea, creatinine, eGFR
Bone profile	calcium, corrected calcium, albumin, alkaline phosphatase, phosphate
Liver profile	ALT, alkaline phosphatase, total Bilirubin, albumin, total protein
Lipid profile	cholesterol, triglyceride, HDL, calculated LDL. ***Must be fasting sample for full profile.***
Thyroid profile	TSH and free T4, other tests are added if necessary by laboratory clinical scientists
Iron profile	Iron , Transferrin and iron saturation

SAMPLE VOLUMES

One fully filled 4.5 ml yellow topped Vacutainer will generally contain sufficient blood for analysis of all profiles listed above. However this does depend on the MCV of the patient and assumes that a minimum of 2mls of serum is able to be separated

For single analytes 1 ml of whole blood is usually sufficient.

For all assays not quoted above please send one full tube of the correct type, if collection of multiple tubes causes a problem please call the duty biochemist for advice.

Blood samples

AVOID CONTAMINATION - When taking a series of blood specimens, it essential that the yellow top serum sample is taken first, followed by green top Lithium heparin samples then the grey top Fluoride Oxalate samples and any EDTA tubes last of all. Failure to adhere to this sequence will lead to contamination of blood samples with anticoagulants/preservatives. This contamination produces spurious and invalid results.

Avoid haemolysis, drip contamination, adverse temperatures (over 30^{o}C or less than 10^{o}C, unless otherwise stated) and prolonged venous constriction.

Ensure thorough and instant mixing of blood with anticoagulant (heparin, fluoride oxalate or potassium EDTA) for plasma samples.

Do not transfer blood from one tube to another e.g. EDTA to Lithium Heparin.

Do not leave Clinical Biochemistry blood samples in the fridge (4°C) or overnight at room temperature. If in doubt, please contact the laboratory (Duty Biochemist bleep 4375) for advice.

Leaking blood tubes will be discarded.

Controlled Document

DO NOT send blood gas samples to the laboratory via the pneumatic tube systems.

DO NOT send blood gas samples to the laboratory with the needle attached.

Urine samples

General points

- Most of the urine assays are normally reported as a 24 hour output, and a full 24 hour collection is required. Please ensure that start and end dates and times are noted on the bottle label.
- Random samples or overnight collections are adequate for some tests and these are marked in the table.
- Some analyses require a specific preservative in the collection bottle (see table) - ***check before starting collection***. Special bottles are held by the Biochemistry Department and can be collected from there or the reception area in the Clinical sciences building by the portering service or ward staff.
- Please complete the bottle label as well as the request form.
- **Creatinine clearances** can only be calculated if the blood creatinine is measured within 24 hours of the 24 hour urine.

Pleural fluid samples

For general biochemistry collect into a red or yellow top tube, glucose into a fluoride oxalate (grey top) and sample for acid base assessment collected into a blood gas syringe and treated as a blood gas specimen. A simultaneous blood sample for general biochemistry into a yellow top tube and glucose into a fluoride oxalate grey top tube will be helpful for interpretation. See page 41 for Light's criteria for evaluating pleural fluid.

REFERENCE RANGES

Reference ranges are supplied strictly for guidance only, and these should be used rather than those quoted in textbooks, diaries etc, as both methods and units vary from department to department. These should not be published as methodology changes in line with the introduction of new techniques the ranges become outdated and therefore are subject to constant review. The current reference/therapeutic range is always included with the final report. ***5% of the healthy population will have results marginally outside the quoted reference range*.** Ranges may be affected by **age**, **gender**, **ethnic group**, **pregnancy**, **time of sampling** and many other factors. Detailed information or advice on interpretation is always available from the laboratory.

Validity of results

Results are automatically validated if they are within preset ranges and have no error flags from the instruments .e.g. Haemolysis, Lipaemia and Icterus. Ranges have been discussed and approved by senior scientists and consultant staff. Results outside these ranges are scrutinised by qualified staff and authorised HCPC registered Biomedical Scientists or the duty Biochemist/Medic or Consultant. Comments may be appended and additional analyses undertaken based on the clinical details provided and on previous results.

Whilst internal and external quality assurance programmes are in operation to ensure accuracy and precision of results, occasionally random errors may occur and escape detection. The clinician is often best placed to detect such errors. Therefore if you doubt the validity of a result, it is vital that you contact the relevant 'Advice/Interpretation' extension at once so that we can investigate and re-test samples whenever possible.

Please remember that certain factors may affect and possibly invalidate some test results, causing potential biological and analytical interference. For example, blood transfusion and other intravenous fluids,

Controlled Document

antibiotics, anticoagulants, drugs, timing of specimen in relation to drug dose, type of tube. Please remember to give details of recent or current treatment on the request forms.

GP samples;

In order to maintain sample viability there is a requirement for samples to arrive within the target times outlined below;

For the routine Biochemistry blood profile tests, blood glucose and HbA1c and endocrine tests that are collected in primary care the target time from venepuncture to delivery in the laboratory is 4 hours with a maximum of 6 hours. This includes samples for PTH collected into EDTA tubes. A small number of specialised tests must be delivered to the laboratory in under this time and / or be transported on ice as indicated in the User Guide for Clinical Biochemistry. These tests are not ones that would normally be collected in primary care. Advice on these specialised tests is provided on a test by test basis by the departmental duty biochemist (0161 276 1234 bleep 4375).

REPORTING OF RESULTS

All results will be issued on a printed report unless clinical users specifically request that this is not done. This may take several forms.

1. **A Cumulative report** giving a maximum of the four most recent results is issued for the majority of profiles and commonly requested single tests.
2. **Single shot** reports are issued for all tests not on Cumulative reports.
3. **Interim** (or **Ward**) reports are also issued in some circumstances or to meet special requirements of some wards. These are temporary reports and should not be stored in the patient's notes.
4. **Electronic Reporting.** This can be carried out in two different ways:

    - The first is **results reporting** back to **OCM** for those requests made by that system.
    - The second is direct to a department's clinical system but this will only be done through a special development arranged with the laboratories.

5. **Telephone reporting** will be used for urgent results for which the other systems would not provide a report quickly enough.

Results which are outside of the limits listed below will be telephoned. Other results may be telephoned if they appear to be inconsistent with previous results or of particularly relevant for diagnostic or treatment purposes

.

Telephone action limits

Abnormal results for key tests will be telephoned to users, the full list of these tests and ranges is available from the department.

Time limits for requesting additional tests

For most general and endocrine requests it is not possible to add on an additional test more than 24 hours from the time that the original results were authorised. This only applies to analytes that are stable at 2-8° C.

REFERRED TESTS

Some specialized or low volume assays are referred to external laboratories for analysis. In line with CPA requirement we endeavour to use CPA accredited laboratories whenever possible. A full list of the tests referred out and the laboratories that are used is available from us; however the more common ones are listed below:

TEST	EXTERNAL LABORATORY
Downs Screening	Royal Bolton Hospital

Controlled Document

Tumour markers (CEA, CA19-9,CA15-3)	Christie Hospital
Specific Proteins; A1AT phenotype; , Carbohydrate Deficient Transferrin	Sheffield Protein Reference Unit
Androgens and Steroids (D-Sulphate, A-dione, female testosterone); Plasma metanephrines and adrenaline	Salford Royal Hospital
Gut Hormones	Hammersmith Hospital
Specialist TDM	Guy's & St. Thomas' Hospital
Serum Lipase	Huddersfield Royal Infirmary

COMMENTS/COMPLAINTS PROCEDURE

Any complaints or concerns about any aspect of the service should be raised initially with the Departmental Laboratory Manager, Ms Christine Hill, telephone 0161 701 1201.

We are keen to know about any problems arising from the laboratory service. Feedback from our users will help in our constant efforts to improve our service.

ACCREDITATION

The department was fully inspected in March 2011 and is now Fully Accredited by CPA (UK) Ltd for all laboratory based analyses. Processes for accreditation for Point of Care Testing (POCT) have been changed by CPA and this process is under review.

Controlled Document

A – Z OF TESTS

These tables cover the most requested tests; please contact the Duty Biochemist for any tests not on these tables.

Specimen requirements and reference ranges for blood analyses

ANALYTE	REFERENCE RANGE	TURNAROUND TIME	SPECIMEN NOTES
11-deoxy cortisol	5.0-12.1 nmol/L	4 weeks	Yellow top tube (Serum) Must be sent to the laboratory on ice for immediate separation. Do not screen routinely for 11 hydroxylase deficiency in adults unless there is significant androgen excess and the cause is not apparent and the result would affect treatment
17 α OH Progesterone	0-10 nmol/L	1 – 2 weeks	Yellow top tube (Serum)
18 hydroxy cortisol	**Supine** 0.7-6.5 nmol/L **Ambulant** 1.6-10.7 nmol/L	4 - 8 weeks	Purple Top Tube (EDTA plasma) or Yellow top tube (Serum). Establish a diagnosis of Conn's before considering this test
Acid - Base status pH pCO2 - arterial pO2 - arterial pO2-capillary actual bicarbonate base excess ; **male** base excess ; **female**	 7.36 - 7.44 4.5 - 6.0 kPa 12.0-14.7 kPa 6.7 - 10.7 kPa 24 - 30 mmol/L -2.3 to + 2.3 mmol/L -3.0 to + 1.6 mmol/L	**Urgent:** 30 mins	Blood gas syringe. Remove needle, cap syringe. **Additional:** ***Do not send this specimen by pneumatic tube.***
ACTH	9am ; 0-46 ng/L	2 - 4 weeks	Green top tube (plasma) **Additional:** ***DO NOT use glass tube. Send to lab in ice immediately. Requires rapid separation***
Adrenaline (see Catecholamines)			
ADH (Arginine vasopressin)	See Report No ranges or units		**Contact Duty Biochemist for interpretation**
AFP - as tumour marker	< 10 KU/L	1 week	Yellow top tube (serum)
Albumin	34 – 48 g/L	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (serum)
Aldosterone Samples taken as random during the day Overnight recumbent	 100-850 pmol/L 100/450 pmol/L (general guidance only)	4 weeks	Green top tube (Plasma) Must be sent to the laboratory for immediate separation **but must not be sent in ice. Screening for Conn's: random aldosterone and renin**

Controlled Document

ANALYTE	REFERENCE RANGE	TURNAROUND TIME	SPECIMEN NOTES
Aldosterone / Renin Ratio	>1000 suggests primary hyperaldosteronism >2000 indicated that the patient almost certainly has hyperaldosteronism (general guidance only)	4 weeks	Green top tube (Plasma) Must be sent to the laboratory for immediate separation **but MUST NOT BE SENT IN ICE as this encourages conversion of pro-renin to renin.**
Alkaline phosphatase (U/L)	**Male:** 40 -129 U/l **Female:** 35 -104 U/L	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (serum)
Alkaline Phosphatase Isoenzymes	Qualitative interpretation. Contact Pancreatic Lab (ext 64067)	2 weeks	Serum or heparinised plasma (One green or yellow top tube)
Alpha – 1 Antitrypsin	1.0 – 2.0 g/L Phenyotyping will be done if results are <1.28 g/L	1 week	Yellow top tube (serum)
Alcohol; (See Ethanol and Methanol in Toxicology section)			
ALT	5 – 40 U/L	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (serum)
Ammonia	5-50 umol/L.	**Urgent:** 2 hours **Routine:** 4 hours	Purple top tube. (EDTA) **Additional:** ***Contact lab on 65180 prior to collection. Sample must be fresh – send to lab in ice immediately.***
Amylase	28-100 U/L	**Urgent:** 2 hours **Routine**: 4 hours	Yellow top tube (serum)
Amylase Isoenzymes	Contact Pancreatic Lab (Ext 64067)	2 - 3 weeks	Serum (One red or yellow top tube)
Androstenedione	**Male:** 2.1-10.8 nmol/L **Female:** 1.0-11.5 nmol/L	2 - 4 weeks	Yellow top tube (serum)
Anti Mullerian Hormone (AMH)	Contact lab or refer to report for guideline	1 - 2 weeks	Yellow top tube (serum). Separate within 2 hours. Store and send cold if less than 24 hours. If > 24 hours, store at -20^{0}C
Anion-Gap	10-18 mmol/L	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (Serum)
Angiotensin converting enzyme (ACE)	20-70 IU/L	1 – 2 weeks	Yellow top tube (Serum)
APO-E genotype	No range	2- 4 weeks	Purple top (EDTA plasma) This is a genetic test and the whole blood sample is required
AST	5 – 45 U/L	**Urgent:** 2 hours Routine: 4 hours	Yellow top tube (serum) (Adults)

Controlled Document

ANALYTE	REFERENCE RANGE	TURNAROUND TIME	SPECIMEN NOTES
β-Carotene **Beta carotene**	19-254 µg/l	4 weeks	Contact Pancreatic lab ext 64067 before drawing blood Serum (One red or yellow top tube)
Bicarbonate	19-28 mmol/L	**Urgent:** 2 hours **Routine:** 4 hours	
Bile Acids	< 14 umol/L	Next day Mon-Fri	Yellow top tube (Serum)
Bilirubin (total **Bilirubin (Conjugated/direct)**	< 22 µmol/L *No range*	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube, Serum (Adults)
BNP ; see NT-proBNP			
Bone Markers; **CTX** **P1NP**	0.1 – 0.5 ug/L **Premenopausal (<56yrs) women** 30-78 µg/L **Postmenopausal (>56yrs) women** 26-110 µg/L **Men** – 20-76 µg/L	2 - 4 weeks	Purple top tube (plasma) Fasting morning sample is preferred Purple top tube (Plasma) **Not affected by fasting**
Ca 15-3	**<32 KU/mL**	1-2 weeks	Yellow top tube (serum) Fluid other than blood should be put into a yellow top tube. However, non of the tumour markers are validated on non-serum fluids and no interpretation is offered
Ca- 125	**<21 U/ml**	1-2 weeks	Yellow top tube (serum) Fluid other than blood should be put into a yellow top tube. However, non of the tumour markers are validated on non-serum fluids and no interpretation is offered
Ca19-9	**<31 U/ml**	1-2 weeks	Yellow top tube (serum) Fluid other than blood should be put into a yellow top tube. However, non of the tumour markers are validated on non-serum fluids and no interpretation is offered
CEA	**0-3.0ug/ml**	1-2 weeks	Yellow top tube (serum) Fluid other than blood should be put into a yellow top tube. However, non of the tumour markers are validated on non-serum fluids and no interpretation is offered
Caeruloplasmin	200-600 mg/L	1 week	Yellow top tube (serum) This is measured by immunoassay, not copperoxidase activity
Carbohydrate deficient Transferrin	Negative <2.6% of total Transferrin	2 - 4 weeks	Yellow top tube (serum). This test is available only

Controlled Document

ANALYTE	REFERENCE RANGE	TURNAROUND TIME	SPECIMEN NOTES
	Positive >2.6% of total Transferrin		after discussion with the duty biochemist or after prior agreement
Carboxyhaemoglobin	<2% non smokers <10% for smokers (approximate)	**Urgent:** 30 mins	*If sent with blood gas;* Blood gas syringe. Remove needle, cap syringe. **Additional:** ***Do NOT send this specimen by pneumatic tube*** **If separate sample;** **Green Top tube (Plasma)**
Calcitonin	< 5.5ng/L **Female** < 18.9 ng/L **Male**	4 weeks	Yellow top tube (serum) **Additional:** ***Send to lab in ice immediately. Requires rapid separation***
Calcium (corrected)	2.10 – 2.55 mmol/L	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (serum)
Catecholamine (Plasma)	Adrenaline 0-1.0 nmol/L Noradenaline 1.0-6.0 nmol/l	4 weeks	Purple top tube (EDTA plasma) ***Send to lab in ice immediately***. *Requires rapid separation*
Chloride	95 -108 mmol/L	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (serum)
Chromogranin A	< 60 pmol/L	8 weeks	Purple top tube (EDTA plasma)
Chromogranin B	< 150 pmol/L	8 weeks	Purple top tube (EDTA plasma)
Cholesterol	JBS 2 Dec 2005 treatment targets; Total <4.0 mmol/l LDL <2.0 mmol/L HDL male >1.0 mmol/l HDL female >1.2 mol/l	**Routine:** 4 hours	Yellow top tube (serum) **Additional:** ***See Joint British Societies 2 guideline.*** ***LDL will only be calculated if TG <or = to 4.0 mmol/L***
Cholinesterase	Total 620 – 1370U/L Phenotype; See interpretive result report issued	4 weeks	Yellow top tube (serum) **Additional:** ***Apnoea investigations should wait until patient is fully recovered.***
Chromium	nmol/L	4 weeks	Purple top tube (EDTA plasma) Requests will be vetted, this assay is only available for monitoring patients with specific types of metallic joint replacements.
CK total	**Male:** up to 190 U/L **Female:** up to 165 U/L	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (serum)
CKMBmass			This test is no longer available.
Cobalt	nmol/L	4 weeks	Purple top tube (EDTA plasma) Requests will be vetted, this assay is only available for monitoring patients with specific types of metallic joint replacements.

Controlled Document

ANALYTE	REFERENCE RANGE	TURNAROUND TIME	SPECIMEN NOTES
Copper	11-20 umol/L	2-4 weeks	Blue top tube (serum)
Cortisol	Mid-night; 60-250 nmol/L 9am; 200 – 650 nmol/L	Next day Mon-Fri	Yellow top tube (serum) Random cortisol is not an effective means of screening for Cushing's syndrome: use 1 mg overnight Dexamethasone suppression or 24 hour urinary free cortisol All samples taken as part of a Synacthen test should be sent to the laboratory in a single batch. A baseline and thirty minute sample is required.
C-peptide	Level depends on glucose concentration	4 weeks	Yellow top tube (Serum) Must be sent to the laboratory on ice for immediate separation. If the test is requested because of hypoglycaemia then an appropriately low glucose taken simultaneously is required and will only be measured if insulin is raised inappropriately
C-reactive protein (CRP)	0.3-5.0 mg/L	Urgent: 2 hours Routine: 4 hours	Yellow top tube (serum) CRP is useful to monitor inflammatory processes and is at least as useful as Orosomucoid for monitoring inflammatory bowel disease for which purpose CRP is preferred
Creatinine Adults	**Male**; 59-104 µmol/l **Female;** 45-84 µmol/l	Urgent: 2 hours Routine: 4 hours	Yellow top tube (serum) May be elevated by Creatine supplements
CTX; see Bone markers			
DHEA sulphate	**Male:** 2.2 – 15.2 µmol/L **Female :**1.0 -12.0 µmol/L	2-4 weeks	Yellow top tube (serum)

Controlled Document

ANALYTE	REFERENCE RANGE	TURNAROUND TIME	SPECIMEN NOTES
FSH	**Male:** 1.5 – 12.4 IU/L **Female** **Follicular:** 3.5-12.5 IU/L **Mid cycle:** 4.7-21.5 IU/L **Luteal:** 1.7-7.7 IU/L **Menopausal:** >30 IU/L	Urgent: 2 hours Routine: 4 hours	Yellow top tube (serum)
Fructosamine	205 – 285 µmol/L	2-3 weeks	Yellow top tube (serum) Provide where an analytically correct measurement of HbA1c cannot be obtained due to the presence of a variant haemoglobin Target ranges for control of diabetes are not well validated. Measurement of HbA1c by different means may solve the problem. NICE suggests direct measurement of glucose day curves, for which HbA1c is a proxy
Gamma-GT	**Male:** 10-71 U/L **Female:** 6-42 U/L	Routine: 4 hours	Yellow top tube (serum) Mainly used to distinguish between liver and other causes of a raised alkaline phosphatise. Should not form part of a routine assessment of liver function
GHRH	See report	4-8 weeks	Red Top (serum)
Glucose	Fasting adult ; 3.0 – 6.0 mmol/L	**Urgent:** 2 hours **Routine:** 4 hours	Grey top tube (plasma) See appendix for diagnosis of diabetes according to WHO criteria
Glutathione (whole blood)	1078-1753µmol/L or 7.49-12.21 µmol/g haemoglobin	2 weeks	Contact Pancreatic lab ext 64067 before drawing blood. One purple top (EDTA)
Glycated Haemoglobin HbA1c	**Tight Glycaemic Control *** HbA1c < 48* mol/mol (NGSP *<6.5%) **Good Glycaemic Control** HbA1c < 59 mmol/mol (<7.5%) **Review Glycaemic Control** HbA1c ≥ 59 mol/mol (≥7.5%) *** Increased risk of significant hypoglycaemia with tight control**	Next day , Mon-Fri	Purple top tube (EDTA plasma) The presence of a variant haemoglobin will be reported. Further investigation of these requires patient consent for further analysis, which is performed in haematology. From 9th Jan. 2012 only IFCC values will be reported.
GTT	Interpretation of results is provided with each report following WHO	Analysed same day as test carried out on ward	*Doctors working in the hospital: contact Programmed Investigation Unit to arrange*

Controlled Document

ANALYTE	REFERENCE RANGE	TURNAROUND TIME	SPECIMEN NOTES
	guidelines.		*ward appointment* . GP referral to Clinical Biochemistry with full contact details of patient
Growth Hormone	Level dependant on age , sex and clinical circumstance ug/L	2-4 weeks	Yellow top tube (serum) Standardised against IS98/574. To compare with previous measurements expressed in mU/L multiply the mass unit by 3 **Random measurements are of little use (see IGF1)**
Gut hormones; **Gastrin** **Glucagon** **CART** **Pancreatic polypeptide** **Somatostatin** **VIP**	<40 pmol/L <50 pmol/L <85 pmol/l <300 pmol/L <150 pmol/L <30 pmol/L	4 weeks	**Patient MUST be fasting** Must send in ice and collected in special tube provided by the laboratory (contact 276 5180) **These samples must be taken using a syringe and needle as the preparation of the tubes leads to loss of vacuum in them.**
HCG **(as tumour marker)**	0- 2 IU/L	1 week	Yellow top tube (serum) Follow-up testing of trophoblastic tumours usually requires testing of urine HCG and is arranged directly with the clinician by the designated national centre (Sheffield in our case)
Homocysteine	<15 umol/L	2-4 weeks	Grey Top (Fl.ox. plasma) ***Must be sent to the laboratory for immediate separation*** ***Fasting sample preferred****.* *Not routinely available as a cardiovascular risk factor.*
Immuno-reactive Trypsin	See report	2-4 weeks	Green top tube , whole blood or preferably blood spots
Inhibin B	80-150 pg/ml	2-4 weeks	Yellow top tube (serum). Routinely available only as a granulosa cell tumour marker
Insulin	2.3 – 26.0 mIU/L (fasting)	1 week	Yellow top tube (Serum) Must be sent to the laboratory on ice for immediate separation. A simultaneous fluoride oxalate sample for glucose must be provided
Insulin Like Growth Factor 1 **IGF-1**	Complex age-related ranges. See the range on your report or contact the duty biochemist.	1-2 weeks	Red top tube (Serum) Preferred test for screening for acromegally

Controlled Document

ANALYTE	REFERENCE RANGE	TURNAROUND TIME	SPECIMEN NOTES
Iron (and iron status) **Transferrin** **% iron saturation**	7 – 29 µmol/L 2.0 – 3.6 g/L 15%-45%	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (serum) Ferritin provided by haematology is a better test of iron deficiency. Measurement of iron is not necessary Iron saturation is more sensitive than ferritin for detecting iron overload
Lactate	0.6 – 2.5 mmol/L	**Urgent:** 2 hours	Grey top tube (plasma) Specimen to be sent to laboratory immediately within an hour but must be separated immediately so lab staff must be alerted
Lead *Environmental exposure guidelines*	< 250 ug/L	Routine 5 working days	Purple top tube (EDTA Plasma) If environmental testing in the work place is undertaken, arrangements must be made to store a sample for confirmatory testing
LDH	20 – 220 U/L	Routine: 4 hours	Yellow top tube (serum) **Additional:** ***By special arrangement***
LH	**Male** 1.7 – 8.6 IU/L **Female** **Follicular:** 2.4-12.6 IU/L **Mid cycle:** 14 – 95.6 IU/L **Luteal:** 1.0-11.4 IU/L	Next day Mon-Fri	Yellow top tube (serum)
Magnesium	0.7 – 1.0 mmol/L	**Urgent**: 2 hours **Routine:** 4 hours	Yellow top tube. (serum)

Controlled Document

ANALYTE	REFERENCE RANGE	TURNAROUND TIME	SPECIMEN NOTES
Manganese	<1 year 7-18 ug/L > 1yr 4-12 ug/	2-4 weeks	Purple top tube (EDTA Plasma)
Met-haemoglobin	< 1.5%	**Urgent:** 2 hours **Routine:** 4 hours	**If sent in a blood gas syringe**, for additional measurement of acid base parameters, remove needle and cap syringe**.** ***DO NOT send this specimen by pneumatic tube*** **If separate sample;** Green Top tube (Plasma)
Noradrenalin (see catecholamines)			
NT pro-BNP	Up to 400pg/ ml	**Only available routinely for GP samples.**	Yellow top tube (serum)
Oestradiol	Men:99 – 192 pmol/L Women: Follicular phase 98 – 571 pmol/L Mid cycle 177 – 1153 pmol/L Luteal phase 122 - 1094 pmol/L	Next day , Mon-Fri	Yellow top tube **Additional:** ***Measurement of Oestradiol is not recommended for monitoring of HRT.***
Orosomucoid	300 – 1200 mg/L	2-4 weeks	Yellow top tube CRP is equally efficacious for monitoring inflammatory bowel disease
Osmolality (serum) (calculated as 2 x (Na + K) +glucose + urea)	275 – 295 mmol/kg	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (serum)
Osmolar Gap **(**measured Osmolality – Calculated Osmolality**)**	<10 mmol/L	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (serum)
Oxalate		2-4 weeks	Purple top (EDTA Plasma) **Must be separated and frozen within 1hr of collection**
PINP (see Bone markers)			
PIIINP	1.7 – 4.2 ug/L	3-4 weeks	Yellow top tube (serum)
Phosphate	0.7 - 1.4 mmol/L	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (serum) (Adults)
Plasma L3-methoxytyramine	<180 pmol/L	3-4 weeks	Yellow top tube (serum)
Plasma Metanephrines	<510 pmol/L	3-4 weeks	Yellow top tube (serum)
Plasma Normetadrenaline	<118 pmol/L	3-4 weeks	Yellow top tube (serum)
Potassium	3.5 – 5.5 mmol/L	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (serum)
Pregnancy test			

Controlled Document

ANALYTE	REFERENCE RANGE	TURNAROUND TIME	SPECIMEN NOTES
(see Quantitative HCG)			
Procalcitonin	Consider stopping antibiotics if Procalcitonin concentration has decreased by more than or equal to 80% from the PEAK concentration or is less than 0.5 ug/L.	Same day	Yellow top tube (serum)
Progesterone luteal peak	 >30 nmol/L consistent with ovulation	Next day, Mon-Fri	Yellow top tube (serum)
Prostate Specific Antigen (PSA) 50-59 yrs 60-69 yrs 70 and over **Free PSA by equimolar analysis**	 <3.0 ng/ml <4.0 ng/ml <5.0 ng/ml (Department of Health Referral Guidelines 2002) Interpretation is by close scrutiny of latest evidence	Next day, Mon-Fri Variable depending on demand	Yellow top tube (serum) Yellow top tube
Prolactin Total; Free Prolactin	 **Male:** 86-324 mU/L **Female:**102 – 496 mU/l **Male:** 67 – 251 mU/L **Female:** 79 – 384 mU/L	Next day, Mon-Fri	Yellow top tube (serum) Free Prolactin will be measured if there are two consecutive elevated prolactins not explained by hypothyroidism, antidoaminergic drugs, or pregnancy. However, samples referred from Endocrinology will automatically be assessed for free □rolactin if □rolactin is elevated. Free □rolactin will only be estimated once in each patient
Protein (total	60 – 80 g/L	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (serum)(Adults).
PTH	10 – 60 pg/ml	Same day	Purple top (EDTA plasma)
PTHrp	Set report	2-4 weeks	Needs special tube , contact laboratory on 276 5180, **must be sent on ice for rapid separation**. A PTH should have been found to be suppressed and hypercalcaemia demonstrated. However modest artefactual elevation of PTH above suppressed levels may be seen if eGFR is reduced

Controlled Document

ANALYTE	REFERENCE RANGE	TURNAROUND TIME	SPECIMEN NOTES
Quantitative HCG *If used for Ectopic Pregnancy see Clinical Guideline*	Quantitative HCG used as a pregnancy test; A result of >25 U/L would normally indicate a positive test but, a result of <25 U/L does not exclude early pregnancy.	**Urgent:** 2 hours Same Day	Yellow top tube (serum) Interpretation of HCG in the context of monitoring early pregnancy is not provided by the laboratory
Renin Samples taken at random during the day Over night recumbent 30 minutes upright Random	 0.5 – 3.5 nmol/L/h 1-2.7 nmol/L/hr 2.8 – 4.5 nmol/L/hr 0.5- 3.5 nmol/L/hr	2-4 weeks	Green top tube (Plasma). Dark green tubes (no gel) are preferred, light gree**n** (with gel**l**) are acceptable. Must be sent to the laboratory for immediate separation **but must not be sent in ice as this encourages conversion of pro-renin to renin.**
Retinol Binding Protein	0 – 0.3 mg/L	1- 2 weeks	Yellow top tube (serum)
Selenium	0.8-1.5 umol/L	3-4 weeks	Serum (One red or yellow top tube)
SHBG	**Male:**15 – 47 nmol/L **Female:** 20 – 110 nmol/L	1-2 weeks	Yellow top tube (serum)
Sodium	133 – 146 mmol/L	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube (serum). **Additional:** ***Hyponatraemia Guidelines Available***
Thiopurine Methyltransferase TPMT	nmol/g Hb/hour <5 deficient 6-34 low 35-79 normal >80 high	1-2 weeks	Pink or Purple top (EDTA plasma) **Additional:** **Recent blood transfusion may mask a deficient TPMT result.**
Tri-oidothyronine – Free (free T3)	3.6 -6.4 pmol /L	1-2 weeks	Yellow top tube (serum) **Additional:** ***Not standard part of Thyroid Function Test***
Tri-iodothyronine – Total (T3) not routinely available	1.3 – 3.1 nmol/L	1-2 weeks	This assay is no longer routinely available. Contact the duty biochemist if you feel this is required.
Testosterone	**Male:** 10 – 35 nmol/L **Female:** < 1.8 nmol/L		Yellow top tube (serum) SHBG and FAI will be reported with all female testosterone results

Controlled Document

ANALYTE	REFERENCE RANGE	TURNAROUND TIME	SPECIMEN NOTES
Thyroglobulin (Thyro)	< 55 ug/L	1-2 weeks	Yellow top tube (serum) Used as a tumour marker. Thyroglobulin antibodies may interfere with the assay and levels will be reported with the test result
Thyroid Binding Globulin (TBG)	See report.	1-2 weeks	Yellow top tube (serum) Not usually necessary as part of TFT because free T4 is measured
Thyroxine – Free (free T4) **See TFT guideline at end of this table.**	9 – 24 pmol/L	1-2 weeks	Yellow top tube (serum) Low levels of binding protein usually reflected by a low albumin cause low results. High levels of TBG, as occur in pregnancy or HRT, have no effect
Total Protein	60-80g/L	Routine ; same day	Yellow top tube (serum)
Transferrin	2.0 – 3.60 g/L	Routine ; same day	Yellow top tube (serum) Provided as part of iron profile and used as the denominator to calculate iron saturation
Triglycerides	Fasting guideline;JBS 2 Dec 2005 treatment target an optimal level <1.7 mmol/l	Same day	Yellow top tube (serum)
Troponin T **New high sensitivity assay introduced 6th Oct. 2010.** **See clinical guideline at end of this table.**	< 14.0 ng/L (99th centile of reference range and limit of detection)	**Urgent:** 1 hour **Routine:** 4 hours	Yellow top tube (serum) NICE has recommended a testing protocol at admission and 6 hours later for hs-cTnT.
TSH **See TFT guideline at end of this table.**	0.2 – 5.0 mU/L	Same day	Yellow top tube
Urate	**Male:** 0.17 – 0.48 mmol/L **Female:** 0.14 – 0.39 mmol/L	Routine: 4 hours	Yellow top tube
Urea	3.5 – 7.4 mmol/L	**Urgent:** 2 hours **Routine:** 4 hours	Yellow top tube
Vitamins; **Vitamin B1** **Vitamin B2** **Vitamin B6**	See individual reports	1-2 weeks	Vit A & E ;Yellow top tube B Vitamins; Purple top (EDTA plasma)
Vitamin E (Tocopherol)	5 – 15 mg/Ll	4 weeks	Red top tube (Serum)
Vitamin A (Rretinol)	0.2 – 0.8 mg/L	4 weeks	Red top tube (Serum)
Vitamin C	4-20mg/l	3 weeks	Contact Specialist Biochemistry lab before drawing blood (Ext 64067). 2 heparinised green top tubes
Vitamin D (total 25OH)	Vitamin D < 25 nmol/l	1-2 weeks	Serum (one red or yellow top tube)

Controlled Document

ANALYTE	REFERENCE RANGE	TURNAROUND TIME	SPECIMEN NOTES
	Deficient - treatment required Vitamin D 25-50 nmol/l Associated with an increased disease risk and treatment is usually required Vitamin D 51-75 nmol/l Adequate – treatment may be required if clinically indicated Vitamin D >75 nmol/l Optimal Vitamin D status		
Vitamin D ($25OHD_2$ & $25OHD_3$)	See Total 25OH Vitamin D	See Total 25OH Vitamin D	$25OHD_2$ and $25OHD_3$ are measured separately and added together to give total 25OHD
Vitamin D (1-25 OH)	48-120 pmol/l	4 weeks	Serum (one red or yellow top tube)
Zinc	**Male** 9.5-18.5 umol/L **Female** 9.5-22.5 umol/L	2-4 weeks	Blue top tube

High sensitivity troponin T guideline, CMFT

- Acute coronary syndromes incorporate two conditions:
  - Unstable angina, and
  - Acute myocardial infarction (AMI), which is further differentiated into:
    - ST elevation myocardial infarction (STEMI), which can be diagnosed using an ECG, and
    - Non-ST elevation myocardial infarction (NSTEMI), which can only be reliably diagnosed using cardiac biomarkers
- Cardiac troponin is the biomarker of choice for diagnosing or excluding acute myocardial infarction (AMI)
- CMFT currently uses the high sensitivity troponin T assay from Roche Diagnostics (hs-cTnT)
- In patients whose symptoms and/or signs lead treating clinicians to suspect a diagnosis of acute coronary syndrome, hs-cTnT should be measured at the time of admission or as soon as possible following the onset of symptoms.
- The test should be repeated 12 hours after the onset of the peak symptoms.
- The lowest reportable level of hs-cTnT is 3ng/L (the 'limit of blank' or LoB)
- The 'normal range' of hs-cTnT is <14n/gL (the 99th percentile in apparently healthy individuals)
- Levels between the limit of blank (3ng/) and 14ng/L are **normal** and will be detected in more than half of apparently healthy individuals
- If any patient has a hs-cTnT level >14ng/L they should have a second sample sent for hs-cTnT testing **6 hours later**.

Haemolysis

- Haemolysis can cause a falsely low level of hs-cTnT
- AMI must **not** be 'ruled out' using a haemolysed sample

Controlled Document

- Haemolysed samples cannot be used to quantify the rise and/or fall of hs-cTnT on serial testing (the **'delta troponin'**).
- A **positive** hs-cTnT (>14ng/L) may still be used to risk stratify patients, even in the presence of haemolysis. However, the sample should still be repeated immediately in order to allow quantification of the rise and/or fall.

To 'rule out' AMI

- In patients who present to hospital >12 hours after the onset of peak symptoms, a single hs-cTnT level <14ng/L can be used to **rule out** AMI**.** However:
  - The clinician should be certain that the **peak** symptoms occurred >12 hours ago. If there is any doubt, repeat the test 12 hours after the **latest** symptoms.
- In patients who present to hospital <12 hours after the onset of peak symptoms, or whose symptoms occur while in hospital:
  - AMI can be ruled out if **both** hs-cTnT levels are <14ng/L
- Patients with hs-cTnT levels >14ng/L may still have AMI 'ruled out' if they do not demonstrate a significant rise and/or fall (delta troponin) on serial testing (see below). 'Ruling out' AMI in these circumstances is a clinical decision and must be based on the clinical context, putting together all of the relevant clinical information for the individual patient. Review by a senior clinician with expertise in this area is recommended. In order to 'rule out' a rise and/or fall of hs-cTnT, **serial samples should be taken 6 hours apart**.
- In patients who present for medical attention very late (>72h) after symptom onset, hs-cTnT levels may have returned to baseline, precluding the detection of a rise and/or fall of hs-cTnT. If there is ongoing suspicion of late-presenting AMI, additional investigation is recommended.

To 'rule in' AMI

- **Hs-cTnT cannot 'rule in' AMI.** The result must be interpreted in the clinical context. A diagnosis of AMI can be established in the following circumstances:

A rise and/or fall of hs-cTnT to above 14ng/L in conjunction with at least one of:

- ***Symptoms of myocardial ischaemia***
- ***New or presumed new ST-segment-T wave changes or new left bundle branch block in the ECG***
- ***Development of pathological Q waves in the ECG***
- ***Imaging evidence of new loss of viable myocardium or new regional wall motion abnormality***
- ***Identification of an intracoronary thrombus by angiography or post-mortem***

Thyroid Function Tests

Adequate clinical information, including a drug history is essential in order to provide information of most value in the diagnosis and management of thyroid disorders.

The first line investigation is freeT4 and TSH

Further tests, including free T3, will be performed as considered appropriate. Generally free T3 is always elevated if FT4 is elevated and so its measurement is unnecessary. Free T3 is added to detect T3 toxicosis when FT4 is normal but the TSH is below normal and to monitor T3 toxicosis and to monitor thyroid function in patients on Amiodarone. Otherwise it will not be measured unless there is some other complicating factor that has been discussed with the duty biochemist.

Other assays such as free hormone investigations and TBG are sometimes helpful but not usually necessary- The use of these assays and any interpretative problems can be discussed with the Duty Biochemist.

Controlled Document

SPECIMEN REQUIREMENTS AND REFERENCE RANGES FOR BLOOD ANALYSES (Paediatric)

See separate Paediatric Biochemistry User Guide

Controlled Document

Toxicology and Therapeutic Drug Monitoring (TDM)

The Toxicology Section provides a laboratory service to support the diagnosis, management and prevention of poisoning. Tests required to diagnose and facilitate specific emergency treatment, e.g. with antidote, are available at as indicated in the A-Z of analytes and conform to the NPIS/ACB Joint Guidelines for Laboratory Services for Acute Poisoning . Tests for the identification of a wide range of common toxic drugs and other poisons are available by arrangement during normal laboratory hours (8.00am – 5.00pm Monday to Friday excluding Bank Holidays) telephone the Toxicology Laboratory on 0161 276 4699 or bleep the Duty Biochemist. Measurement of blood concentrations of the drugs included in the A-Z of Tests is provided for individual optimisation of dose (TDM) and to allow a rational approach to re-instating treatment following overdose.

In all Toxicology/TDM investigations interpretation is dependent on timing. The time of specimen collection and time of last dose (or exposure for poisoning) should be recorded on the request form. Time of specimen collection should be recorded on the sample tube. This is important in acute poisoning as well as TDM as sequential sampling can give information as to the severity of poisoning and the need for additional treatment.

In all unconscious patients and cases of suspected poisoning with drugs the first available urine specimen should be retained.

It is important to give presenting clinical features and full details of suspected poisons and medication on the request form as these are required for interpretation.

TDM
Details of the total daily dose (or individual doses and times) should be given for all medications not just the drugs being measured.
Blood for lithium measurement should be collected 12+/-0.5 hours post dose. For most other TDM pre-dose (trough) sampling is preferred. After initiation or dose adjustment at least 5 plasma half-lives should be allowed to elapse before sampling to allow a steady state to be achieved before checking for adequacy of dose. For pharmacokinetic data and information on dose adjustment see the Therapeutic Drug Monitoring guidelines (Adults).

Controlled Document

Specimen requirements for Toxicology and Therapeutic Drug Monitoring (TDM)

Test	Therapeutic Range	Turnaround Time	Specimen Notes
Amiodarone	0.6-2.5 mg/l	4 weeks	Yellow top tube (serum) Pre-dose By arrangement only
Amitriptyline	50 –150 ug/l	4 weeks	Yellow top tube (serum) Pre-dose By arrangement only
Carbamazepine	4- 12 mg/l	Routine: 1 week Urgent: 4 hours	Yellow top tube (serum) Pre-dose Urgent by arrangement
Clomipramine	150-450 ug/L	4 weeks	Yellow top tube (serum) Pre-dose
Ciclosporin (cyclosporin)	100-300 ug/l	In patients same day Mon-Fri (if in lab before 10.30am	Purple top tube (EDTA whole blood) Pre-dose
Digoxin	1.0-2.0 ug/l Target for heart failure: 0.7ug/l (0.5-1.0 ug/l)	Routine: same day Urgent: 2 hours	Yellow top tube (serum) Pre-dose or at least 6 hours post dose Urgent by arrangement

Test	Therapeutic Range	Turnaround Time	Specimen Notes
			Toxicity increased by hypokalaemia
Dosulepin (dothiepin)	20-60 ug/l	4 weeks	Yellow top tube (serum) Pre-dose By arrangement only
Drugs of Abuse Screen: amphetamines barbiturates benzodiazepines cannabinoids cocaine methadone opiates integrity tests	Reported as positive or negative	same day Mon-Fri or next working day	Random urine in Universal container (min volume 1ml) Detects only those drug classes indicated Give full medication details as these are required for interpretation
Ethanol	as antidote (e.g. methanol) 800-1200 mg/l Legal limit for driving 800 mg/l	Routine: same day Urgent: 2 hours	Grey (Fluoride oxalate plasma) or yellow top tube (serum)
Ethosuximide	40-100 ug/l	4 weeks	Yellow top tube (serum) Pre-dose By arrangement only
Ethylene glycol	See Toxbase	2-3 days Urgent /out of hours analysis can sometimes be arranged but cannot be guaranteed	Grey (Fluoride oxalate plasma)
Flecainide	0.4-1.0 mg/l	4 weeks	Yellow top tube (serum) Pre-dose By arrangement only
Imipramine	10-110 ug/l	4 weeks	Yellow top tube (serum) Pre-dose By arrangement only
Lamotrigine	3.0 -15.0 mg/l	1 week	Yellow top tube (serum) Pre-dose
Lithium	0.4-1.0 mmol/l	Routine: next normal working day (Mon-Fri) Urgent: 2 hours	Yellow top tube (serum) 12+/-0.5 hours post dose
Methanol		2-3 days Urgent /out of hours analysis can sometimes be arranged but cannot be guaranteed	Grey (Fluoride oxalate plasma)
Methotrexate	Action as protocol	Routine: 2 working days Urgent: same day Mon-Fri Urgent analysis out of hours can sometimes be arranged but cannot be guaranteed	Yellow top tube (serum) Collect as protocol Urgent by arrangement
Mycophenylate	2.5-4.5 mg/L	2 weeks	Purple top tube (ETDA plasma) Pre-dose
Paracetamol	10-20 mg/l In overdose refer to treatment graph	Routine: same day Urgent: 2 hours	Yellow top tube (serum) At least 4 hours after overdose. Record times of ingestion and sample collection

Controlled Document

Test	Therapeutic Range	Turnaround Time	Specimen Notes
Phenobarbitone	15-40 mg/l	1 week	Yellow top tube (serum) Pre-dose
Phenytoin	5-20 mg/l	1 week	Yellow top tube (serum) Pre-dose
Salicylate	Analgesic 20 -100 mg/l Anti-inflammatory 100 -250 mg/l Overdose: see Toxbase or BNF	Routine: same day Urgent: 2 hours	Yellow top tube (serum) Repeated measurement may be required. Record times of ingestion and sample collection
Sirolimus	5-10ug/L Overdose: see Toxbase or BNF	1 week	Purple top tube (EDTA whole blood) Pre-dose
Tacrolimus (Prograf, FK506)	3-15 ug/l	Same day Mon-Fri (if in lab before 10.30am)	Purple top tube (ETDA whole blood) Pre-dose
Theophylline	10-20 mg/l	Routine: same day Urgent 2: hours	Yellow top tube (serum) Pre-dose
Toxicology screen-urine	LC-MS. Detects a wide range of therapeutic and misused drugs. Only compounds found are reported	1 week	Random urine in Universal container (min volume 2ml) Additional TLC screen(s) depending on volume (5ml per screen) Full details of suspected poisons/medications required for interpretation
Valproate	50-100 mg/l	1 week	Yellow top tube (EDTA plasma) Pre-dose

Controlled Document

URINE SAMPLES

URINE PLAIN BOTTLES			
Test	**Therapeutic Range**	**Turnaround Time**	**Specimen Notes**
18 Hydroxy Cortisol	40-550nmol/24 hrs	1 month	Plain bottle. This should only be requested when a diagnosis of primary hyperaldosteronism has been established
Amino acids-Random Collection		2 weeks	Full drug history must be included with the request.
Albumin excretion	< 10µg/minute	1 week	Plain bottle Additional: *Preferred timed overnight collection*
Albumin/creatinine ratio	**Male**; 0 – 2.5 mg/mmol **Female;** 0 – 3.5 mg/mmol	2 working days	Plain bottle Additional: *Random sample – preferred first sample on waking*
Cortisol – free	< 165 nmol/24 hr	2-4 weeks	Plain bottle
Creatinine		**Routine:** Next day Mon-Fri **Urgent:** Same day	Plain bottle
Electrolytes	Related to intake	**Routine:** Next day Mon-Fri **Urgent:** Same day	24 hour collection or random Plain bottle
Homocysteine		1- 2 weeks	24 hour collection Plain bottle
Lead		1- 2 weeks	24 hour collection or random Plain bottle
Mercury		1- 2 weeks	24 hour collection or random Plain bottle
Osmolality	Related to blood osmolality	**Routine:** Next day Mon-Fri **Urgent:** Same day	24 hour collection or random Plain Bottle
PABA	PABA excretion index (PEI) >0.70	Contact Pancreatic Lab to order test (Ext 64067)	Contact Pancreatic Lab to order test (Ext 64067)
Porphobilin(ogen)		**Routine:** Next day Mon-Fri	Very fresh RANDOM sample sent straight to lab. Protected from light.
Porphyrins		Screen 4 hours Quantitation if positive 1–2 weeks	Very fresh RANDOM sample sent straight to lab. Protected from light. EDTA blood sample
Porphyrin screen			Whether patient's present with an acute Porphyria or a skin rash a similar approach is taken requiring a fresh random urine sample protected from light and an EDTA blood sample.

Controlled Document

URINE PLAIN BOTTLES			
			If there is a known family history of acute Porphyria an EDTA sample for genetic analysis is required and also faecal analysis may be necessary but faeces need not be sent in the first instance
Protein **Protein Creatinine ratio**	< 150 mg/24 hr A positive test for proteinuria in adults is greater than 45 mg/mmol creatinine.	**Routine:** Next day Mon-Fri **Urgent:** Same day	Plain bottle Used as a screening test for proteinuria UK CKD guidelines.
Urate	3 – 12 mmol/24 hr	**Routine:** Next day Mon-Fri **Urgent:** Same day	Plain bottle
Urea		**Routine:** Next day Mon-Fri **Urgent:** Same day	Plain bottle
Urobilin(ogen)	Quantitative test	**Routine:** Next day Mon-Fri **Urgent**: Same day	Random urine

URINE; (ACID PRESERVATIVE BOTTLES)			
%-HIAA	0-50 umol/24 hr	1 week	
Calcium	2.5 – 7.5 mmol/24 hr	**Routine:** Next day Mon-Fri **Urgent:** Same day	Acid bottle required
Citrate		2-4 weeks	Acid bottle required
Cystine/ Homocystine		2-4 weeks	Acid bottle required
Magnesium	3.3 – 5.0 mmol/24 hr	2-4 weeks	Acid bottle required. Avoid metal capped MSU containers because of the danger of contamination
Oxalate	< 0.32 mmol/24 hr	2-4 weeks	Acid bottle required
Phosphate	15 – 50 mmol/24 hr	**Routine:** Next day Mon-Fri **Urgent:** Same day	Acid bottle required
Total Metadrenalines ***Salford Royal Hospital issues the***	**Males** 0.95-5.26 µmol/24 hr **Females** 0.6-4.2 µmol/24 hr **Male & female**	2-4 weeks	Acid bottle required

Controlled Document

URINE; (ACID PRESERVATIVE BOTTLES)			
following guidelines on individual analytes **Metadrenalines**	0.0 – 2.0 umol/24hr		
Normetadrenaline	**Male** 0.0 – 5.3 umol/24hr **Female** 0.0-4.3 umol/24hr		

***IMPORTANT Health and Safety Notice:**

- These bottles contain 25% Hydrochloric Acid
- Keep the bottles out of the reach of children.
- In case of contact with eyes or skin rinse immediately with plenty of water and seek medical advice
- DO NOT breathe any fumes from this bottle
- **Patients must be advised NOT TO URINATE DIRECTLY into the bottle.**

URINE ACID WASHED (PLASTIC BOTTLES)			
Copper	< 0.8 µmol/24 hr	2-4 weeks	Acid washed bottle required
Iron	Not routinely available, Contact Haematology for Haemosiderin		

Controlled Document

Reference ranges and specimen requirements for CSF ANALYSES

Urgent analysis of CSF for protein and glucose is available at all times. Queries regarding any other aspect of CSF analysis can be directed to either 0161 276 4697, or the duty biochemist

Analyte	Reference range	Turnaround time	Specimen notes
Protein (total)	0.05-0.45 g/L	**Routine:** Next day Mon-Fri **Urgent:** Same day	Plain 5 ml tube – obtained from Biochemistry. *1 ml of CSF, if possible, required*
Glucose	2.0 – 4.5 mmol/L	Routine: Next day Mon-Fri Urgent: Same day	Grey top tube. *1ml of CSF, if possible, required*
Oligoclonal Bands	Not seen in healthy subjects	2-4 weeks	Plain 5 ml tube - obtained from Biochemistry. Clotted blood must be sent at same time.*1 ml of CSF, if possible, required*
Tau Proteins	No range Test reported as +ve or -ve	2-4 weeks	To check for the presence of CSF in other fluids (for example, discharges from nose or ear), send a few drops of fluid of doubtful origin. A simultaneous blood sample is also required, This assay is expensive and time consuming. Full clinical details are required to support this request and to aid interpretation. Blood must be sent as well.
Xanthochromia Screen	No range Qualitative interpretation	Same day Mon-Friday for samples received by 4pm	**CSF Xanthochromia Collection kits** are available from AMU and from the Laboratory Central Specimen Reception in the Clinical Sciences Centre (CSC). Guidelines for collection are in the packs and on the *Clinical Handbook - Adults* under Measurement of bilirubin in CSF (xanthochromia) (Adults). A minimum of 1 ml CSF is required. If these procedures are not followed, full and valid analysis will NOT be possible.

Controlled Document

Reference ranges and specimen requirements for FAECES

Analyte	Reference range	Turnaround time	Specimen notes
3 day Faecal Fat	10 – 18 mmol/24 hr	2 weeks	MUST BE COLLECTED INTO PRE-WEIGHED CONTAINER SUPPIED BY THE LABORATRY. (phone extn. 64699) NO OTHER CONTAINERS WILL BE ACCEPTED
Occult blood			This assay is no longer available
Faecal Elastase	>200 ug/g stool	3 weeks	Random formed stool sample. Contact Pancreatic lab (Extn. 64067) for collection tube.
Porphyrins	Reported as positive or negative	1-2 weeks	Very fresh RANDOM sample sent straight to lab. protected from light. Testing of PBG will undertaken to exclude acute Porphyria. Out of hours the urgency should be discussed with the consultant on call. An EDTA blood sample should also be sent to allow full characterisation of a defect in Porphyrin metabolism

Controlled Document

Miscellaneous Tests

Dynamic Function Tests
Dynamic function test protocols are available from Biochemistry laboratory, or the Programmed Investigation Unit. Please discuss these tests with the Duty Biochemist or one of the Departmental Clinical Scientists or Medical Staff before embarking upon them.

Sweat Tests
These are carried out by the Biochemistry Department at the Royal Manchester Children's Hospital, please contact them to arrange for the test to be carried out.

Creatinine clearance calculation
If creatinine clearance is specifically requested and a 24 urine and blood sample are received the clearance will be calculated automatically and reported in the normal way.
A. Information used in the calculation:

$$\text{Creatinine clearance} = \frac{U \times V}{P}$$

Where U = urinary creatinine in mmol/L
V = urinary flow rate in ml/minute (see note 1 below)
P = plasma creatinine in mmol/L (see note 2 below)

Additional notes:
1. For a 24 hour urine collection, V = total volume in ml divided by 1440.
2. Plasma creatinine on biochemistry reports is in μmol/L, therefore, P = plasma creatinine (μmol/L) **divided** by 1000

B. Example of calculation:

Assuming a full 24 hour urine collection, the creatinine clearance may be calculated from the reported results for urine creatinine output and plasma creatinine concentration as shown below:-

$$\text{Creatinine clearance} = \frac{UCRO \times 694^*}{PCR} \quad \text{(units are ml/minute)}$$

where
1. the factor 694* takes into account the difference in units and the number of minutes in 24 hours.
2. UCRO = urine creatinine output in mmol/24 hour
3. PCR = plasma creatinine in μmol/L

If any doubts about the calculations, please contact the duty Biochemist (Bleep 4375)]

Controlled Document

POINT OF CARE TESTING (POCT)

Point of Care Testing (POCT) is laboratory testing performed in the clinical setting by non-laboratory healthcare professionals. POCT is subject to the same level of public, professional and judicial scrutiny as conventional laboratory testing.

Commonly used POCT devices include blood glucose meters and blood gas analysers. However, recent advances in technology have increased the repertoire of tests that can be measured by POCT.

As POCT is performed close to the patient the results are available more quickly than if the sample had been sent to the laboratory. This has benefits in the delivery of care to critically ill patients. POCT is also used in less acute settings, such as Out-Patient Clinics to reduce patient waiting times.

There are also disadvantages with POCT compared with laboratory testing. For many POCT tests the equipment used to perform the analysis is not as sophisticated as in the laboratory so the results may not be as accurate. Staff are informed about these important limitations at POCT training sessions. For example, in a patient with decreased peripheral blood flow, glucose levels in capillary finger-stick samples may not reflect the true physiological state. This limitation applies to all POCT glucose meters and has led to two fatalities in Greater Manchester.

CMFT has a well established POCT infrastructure to ensure that the benefits of this exciting technology can be realised while managing the inherent risks and costs associated with it.

The CMFT POCT Policy and multi-professional POCT Committee are central to the governance structure. The POCT Team Leaders, manage operational matters such as evaluating equipment, provision of training programs, writing Standard Operating Procedures, operator proficiency testing, auditing and recording of POCT test results (paper and electronic).

The POCT Team has a comprehensive website to facilitate access to information about the CMFT POCT governance structure and the POCT devices used in CMFT. This includes training dates, Standard Operating Procedures and e-learning competency assessments. Contact details for the POCT Team Leaders are also accessible via the POCT website.

Intranet access to the POCT website:
http://labmed.staffnet.xcmmc.nhs.uk/Point-of-Care-Testing

Internet access to the POCT website:
http://www.cmft.nhs.uk/info-for-health-professionals/laboratory-medicine/point-of-care-testing.aspx

Controlled Document

Light's criteria for evaluating pleural fluid

Analysis
The following tests should be performed

- Pleural fluid protein, glucose and LDH and serum protein, glucose and LDH if available
- Pleural fluid pH if a specimen in a blood gas syringe is available. The sample cannot be analysed if it is not suitable for analysis on the blood gas analyser.

Interpretation

Light's Criteria for a transudate(1)

The ratio of pleural fluid protein to serum protein is less than 0.5
Or
The ratio of pleural fluid LDH to plasma LDH less than 0.6
Or
The pleural fluid LDH is less than 2/3 of the upper reference limit

Although these criteria have been re-evaluated there is no clear cut case for using anything other than Light's criteria(2).

A **pH** < 7.3 is seen with emphysema, tuberculosis, malignancy, collagen vascular disease or oesophageal rupture.

Glucose < 2.2 mmol/L is associated with an emphysema, rheumatoid arthritis, tuberculosis or malignancy.

Other tests may be useful(3)

An exudates is more often associated than a transudate with:

A cholesterol level > 11.7 mmol/L

A pleural / serum Bilirubin ratio <0.6

A pleural - serum albumin gradient of < 12 g/L

Controlled Document

DIAGNOSIS OF DIABETES MELLITUS

Investigation of Suspected Glucose Intolerance

Diagnosis should be based on two independent glucose measurements, unless the patient has symptoms of diabetes. All samples should be collected into fluoride oxalate blood tubes, as glucose deteriorates rapidly in inappropriate samples leading to potential errors in diagnosis.

The recommended initial test is either a two hour post-prandial or a random blood sample:

A non-fasting, venous plasma glucose concentration less than 6.1 mmol/L is normal; 11.1 mmol/L or greater is diagnostic for diabetes mellitus.

A non-fasting, venous plasma glucose concentration between 6.1 mmol/L and 11.1 mmol/L should be followed up by a fasting level.

A fasting venous plasma glucose concentration less than 6.1 mmol/L is normal and one of 7.0 mmol/L or greater, is diagnostic of diabetes mellitus. Between these levels an OGTT can confirm the degree of glucose intolerance.

By measuring **venous plasma glucose** concentration, four possible states of glucose metabolism may be defined:

1. Normal
2. Impaired fasting glycaemia - IFG
3. Impaired glucose tolerance - IGT
4. Diabetes mellitus - DM.

IFG and IGT are intermediate states of carbohydrate intolerance and are risk factors not only for subsequent development of diabetes mellitus but also cardiovascular disease and should form part of a cardiovascular risk assessment.

These conditions are defined as follows in terms of plasma glucose concentration:

1. Normal: fasting venous plasma glucose of less than 6.1 mmol/L

2. IFG: fasting venous plasma glucose of 6.1 to less than 7.0 mmol/L and (if measured) 2 hr post 75g glucose load less than 7.8 mmol/L

3. IGT: fasting venous plasma glucose less than 7.0 mmol/L and 2 hr post glucose load of 7.8 to less than 11.1 mmol/L.

4. DM:

    I. Venous plasma glucose of 11.1 mmol/L or greater, at any time.
    II. Fasting venous plasma glucose of 7.0 mmol/L or greater.
    III. Post 75g OGTT - 2hr venous plasma glucose of 11.1 mmol/L or greater.

HbA1c

Diagnostic threshold for diabetes is ≥ 48 mmol/L

Controlled Document